

REMARKS

New Figures 7-9 have been added. No new subject matter is believed to have been added. Support for new Figures 7-9 can be found in the specification and claims as originally filed. New Figure 7 is simply a projection from original Figure 1 and illustrates a worm wheel assembled into a worm wheel shaft attached to a circular table. New Figures 8-9 illustrate a thickness dimension of worm teeth gradually increasing in a direction of a rotation axis of a drive shaft as originally described at page 7, second full paragraph in the specification.

In the specification, new paragraphs were added after the paragraph ending on line 9 of page 6 to include descriptions of the new Figures 7-9. The paragraph beginning at page 7, line 18 has been amended to include reference to the new Figures 7-9.

Claims 1-5 were pending in this application. Claim 1 is amended. In claim 1, the amendatory language "toward one end of said worm body" is derived from the language in the second full paragraph on page 7 in the original specification. Accordingly, no new subject matter has been added by these amendments. Claims 3 and 4 were withdrawn from consideration by the Examiner as being directed to a non-elected species.

Drawing Objections

The drawings stand objected to under 37 C.F.R. § 1.83(a) for failing to show every feature of the invention specified in the claims. New Figures 7-9 have been added to further illustrate the worm wheel assembled into a worm wheel shaft attached to a circular table and the thickness dimension of the teeth gradually increasing in the direction of the rotation axis of the drive shaft. No new subject matter is believed to have been added in these drawings. Support may be found in the second full paragraph of page 7 and in the original drawings. Reconsideration of these objections is respectfully requested.

Specification Objections

The Examiner states that the Amendment filed on May 27, 2004 is objected to under 35 U.S.C. § 132 because it introduces new matter into the disclosure. The Applicant respectfully points out that no Amendment was filed on or around May 27, 2004. It is assumed that the Examiner is referring to the amendments set forth in the Amendment dated July 9, 2003.

In any event, the Examiner states that the material added which is not supported by the original disclosure is the multiple lead type worm for carrying out annular

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AMENDMENTS TO THE DRAWINGS

The attached sheets of drawings include new Figures 7-9.

Attachments: New Sheets

division of a circular table and a worm wheel assembled into a worm wheel shaft attached to a circular table. The Applicant respectfully disagrees with the Examiner and requests reconsideration of this objection.

The description "for carrying out angular division of a circular table" is based on "As a result, the circular table 24 is rotated, and an angular division is carried out" in the last full paragraph on page 6 of the original specification.

The description "worm wheel assembled into a worm wheel shaft attached to said circular table" is based on "To each worm wheel shaft 14, a circular table 24 is attached" in the first full paragraph on page 6 of the original specification.

In the first and last paragraphs on page 6, the specification clearly describes the angular division of a circular table and the relationship between the worm wheel, worm wheel shaft, and the circular table. The phrase "an angular division is carried out" in the last paragraph on page 6 may also be read as "an angular dividing is carried out".

Additionally, it would be readily understood by any person skilled in the art that a dividing head is an apparatus that performs angular dividing of a circular table. This is a common term of art as evidenced by the Chambers Dictionary of Science and Technology definitions for "dividing head" and "indexing head" attached as Appendix A to the Reply to Final Office Action filed January 7, 2004 and the article entitled "Using a Dividing Head and Making One for Your Lathe" attached as Appendix B to the Reply to Final Office Action filed January 7, 2004. In any event, the use of a dividing head is clearly described in the last paragraph on page 6 of the specification.

Therefore, the Applicant believes that the specification in its original form supports such language added by the July 9, 2003 Amendment and that the Amendment simply provided minor rewording clarifications. Thus, the Applicant submits that no new matter was added by the July 9, 2003 Amendment.

35 U.S.C. § 112 Rejections

Claims 1, 2, and 5 stand rejected under 35 U.S.C. § 112, second paragraph, for indefiniteness. The Applicant believes that the above amendments to claim 1 overcome the Examiner's indefiniteness rejections. Reconsideration of these rejections is respectfully requested.

The Examiner states that it is unclear what is meant by the multiple lead type worm teeth in which the teeth thicknesses gradually increase in the direction of the rotation axis of a drive shaft.

The present Specification discusses multiple lead type worm teeth. Specifically, on page 7, the Specification discusses that the leads are slightly different at the right and left sides of the teeth face. Additionally, on page 9 of the Specification, the adjustment of the backlash is discussed in which tooth thickness plays a part of the adjustment. The original specification and drawings were sufficient for one skilled in the art to understand the gradually increasing tooth thickness. Furthermore, the attached four (4) page excerpt from KMK, a worm gear manufacturer, illustrate what one skilled in the art at the time of the instant invention would have understood from the description at pages 7 and 9 of the application, with respect to variable tooth thickness. Removal of this rejection is in order.

35 U.S.C. § 103 Rejections

Claims 1, 2, and 5 stand rejected under 35 U.S.C. § 103(a) for obviousness over United States Patent No. 5,188,004 to Kitagawa in view of United States Patent No. 4,093,052 to Falk and further in view United States Patent No. 4,047,449 to Popov. In view of the above amendments and the following remarks, the Applicant respectfully requests reconsideration of these rejections.

The present invention features dividing a worm into a drive shaft and a hollow multiple lead type worm independent from the drive shaft and assembling the worm body and the drive shaft displaceably by an assembler. In the present invention, the multiple lead type worm does not mean one in which the thickness of the teeth is gradually changed toward one end and the other end with the center of the worm as a border, but means one having teeth formed such that the thickness is gradually increased from one end to the other end of the worm along the axis of rotation of the drive shaft. With this construction, the worm body can be moved while rotating against the worm wheel without moving the drive shaft and the multiple lead type worm can be displaced in the rotating direction of the drive shaft of the worm, thereby enabling adjustment of backlash.

In the Kitagawa patent, first, a worm wheel "e" is not assembled into a worm wheel shaft attached to a turntable "a". The position of a shaft supporting the turntable "a" is

different from the position of a shaft supporting the worm wheel "e", so that the turntable "a" becomes incapable of rotation.

Second, the "turntable apparatus using a multiple lead type worm" in the present invention is not illustrated in Fig. 1 of the Kitagawa patent.

Third, the Kitagawa patent discloses providing a worm and a drive shaft integrally, that is, assembling the worm into the drive shaft so as not to displace. The Kitagawa patent does not disclose displacing a worm body in the direction of its drive shaft, as required by the present invention. Kitagawa teaches away from the claimed invention.

Last, according to the present invention, the term "multiple" modifies the term "lead" not the term "worm". The term "multiple" is not used to indicate the number of worms. Thus, "multiple lead type worm", according to the present invention, means a worm having a multiple lead, not multiple worms (e.g., not two worms, three worms, etc.). The Examiner states that "a multiple lead type worm" is illustrated in Fig. 1 of the Kitagawa patent. However, in fact, two worms are illustrated in Fig. 1, not "a multiple lead type" worm according to the present invention.

The Falk patent is directed to one embodiment of an assembler, but does not relate to a dividing head for performing angular division of a circular table. The Falk patent does not teach or suggest using the assembler for assembling a worm body and a drive shaft of a multiple lead type worm, as required by the present invention.

The Popov patent is directed to a worm with teeth that have a gradually varying thickness from one end to the other end with the center of the worm as a border. The Popov patent does not disclose a worm having teeth formed such that the thickness gradually increases from one end to the other end of the worm along the axis of rotation of a drive shaft, as required by the present invention.

From the disclosure of the Kitagawa patent, it is not possible to obtain the technical idea of the present invention of displacing a worm body relative to its drive shaft. Further, it is not possible to obtain the technical idea of the present invention of adjusting a backlash by changing the position of a worm. Therefore, according to the turntable apparatus disclosed in the Kitagawa patent, it is not possible to obtain the technical idea of assembling a worm body into a drive shaft so as to be able to adjust a rotational position about the drive shaft and of providing an assembler between the drive shaft and the worm for fixing the position of the worm body relative to the drive shaft.

The Falk and Popov patents do not cure the deficiencies of the Kitagawa patent.

For the foregoing reasons, the Applicant believes that the subject matter of amended independent claim 1 is not rendered obvious by the Kitagawa patent in view of the Falk and Popov patents. Reconsideration of the rejection of claim 1 is respectfully requested.

Claims 2 and 5 depend from and add further limitations to amended independent claim 1 and are believed to be patentable for the reasons discussed hereinabove in connection with amended independent claim 1. Reconsideration of the rejections of claims 2 and 5 is respectfully requested.

Due to the complexity of issues in this case, Applicant requests a telephonic interview with the Examiner to discuss the outstanding rejections. Applicant thus requests that the Examiner telephone Applicant's undersigned representative to schedule an interview prior to issuing another action.

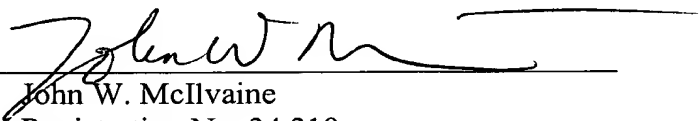
CONCLUSION

Based on the foregoing amendments and remarks, reconsideration of the rejections and allowance of pending claims 1-5 are respectfully requested.

Respectfully submitted,

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KHK Stock Worms, Worm Gears

Available in Speed Reduction Ratios of 1/10 to 1/120 in Many Materials and Styles



Characteristics

The simplest way to obtain a large speed reduction with high torque in a compact space is with worm gear drives. KHK stock worms and worm gears are available in modules 0.5~6 and in speed ratios of 1/10~1/120, made in a variety of materials and styles. We also offer stock duplex lead worms and worm gears with which you can obtain a very low backlash, high rotational precision system.

■Main Features of Types of Worms and Worm Gears Offered

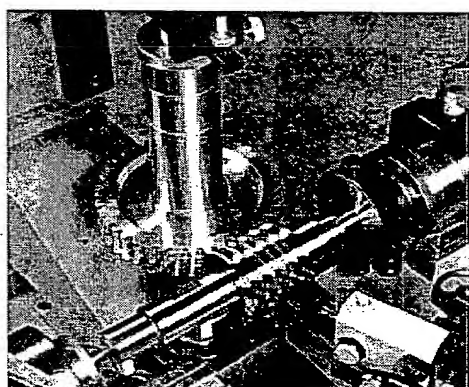
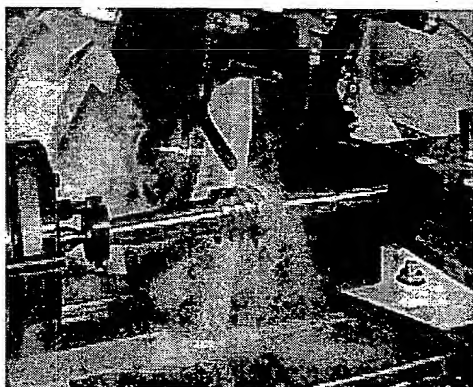
The following table lists the main features for easy selection.

Type		Catalog No.	Module	No. of threads or speed ratio	Material	Heat treatment
Duplex Lead worm gears	Worm	KWGD L	2~6	Single thread	SCM440	Teeth induction hardened
	Worm	KWGDLS	2~6	Single thread~Triple threads	SCM440	Normalized and teeth induction hardened
	Worm gear	AGDL	2~6	1/20~1/60	A0BC2	—
	Worm	KWG	0.5~6	Single thread~Double threads	SCM440	Normalized and teeth induction hardened
	Worm gear	AG	0.5~1.5	1/10~1/60	A0BC2	—

Worm gears	Worm gear	AGF	2~6	1/10~1/60	A \emptyset BC2	—
	Worm	SWG	1~6	Single thread	S45C	Teeth induction hardened
	Worm gear	AG	1~6	1/10~1/60	A \emptyset BC2	—
	Worm	SW	0.8~6	Single~Triple threads	S45C	—
	Worm	SUW	1~3	Single~Triple threads	SUS303	—
	Worm gear	CG	1~6	1/10~1/120	FC200	—
	Worm gear	BG	0.8~6	1/10~1/50	BC6PBC2	—
	Worm gear	PG	1~3	1/10~1/50	MC901	—

NOTE: The material of cast hubs of AGF and AG worm gears is FC200. AG worm gears mate primarily with SWG worms. But, for m0.8 or smaller, AG worm gears mate with KWG worms.

CAUTION: KHK stock worms and worm gears are produced to KHK's own precision grades. See the "Precision of Worms and Worm Gears" in the "Selection Hints" section.



All About Duplex Lead Worm Gears

KHK stock duplex lead worm gears are very specialized products. A good understanding of this section is essential for successful applications.

1. Determining the Backlash

KHK stock duplex lead worm gears (duplex worm gears, for short) are made to KHK Standards W 001 and 002, grade 1 precision. Even though these gears are designed to reduce or eliminate backlash, some amount of backlash is desirable to prevent excessive heat and noise. The backlash adjustment of duplex worm gears must be set, taking into account the total cumulative errors of assembly which include tolerances of gears, casings, etc.

2. Adjusting Backlash of Duplex Worm Gears

Duplex worms have slightly different modules on the right and left faces of the worm teeth. Consequently, the tooth thickness varies as the function of the difference in leads between the right and left face. (Figure 1)

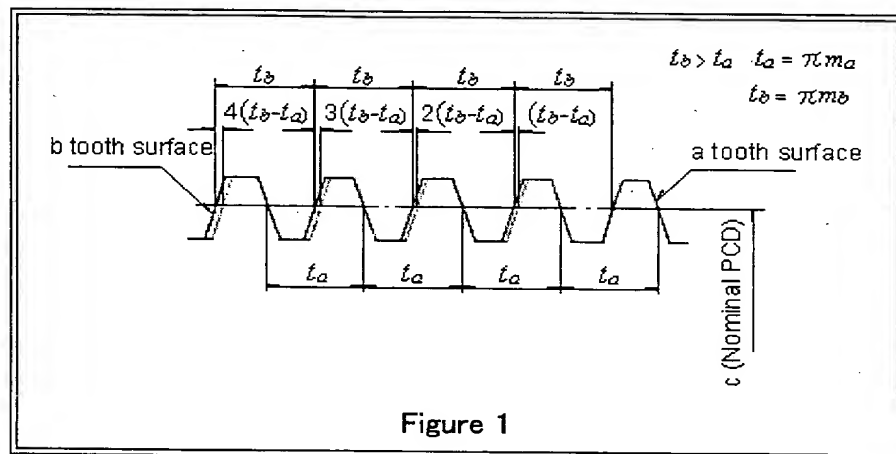


Figure 1

Also a worm gear is cut using a hob which is identical in size to the mating worm at a fixed position relative to the worm gear. Therefore, the tooth thickness and the space between the teeth are consistent throughout the worm gear. By mating a worm with variable tooth thickness with a worm gear which has the same space between the teeth, the backlash can be adjusted with axial movement of the worm. (Figure 2)

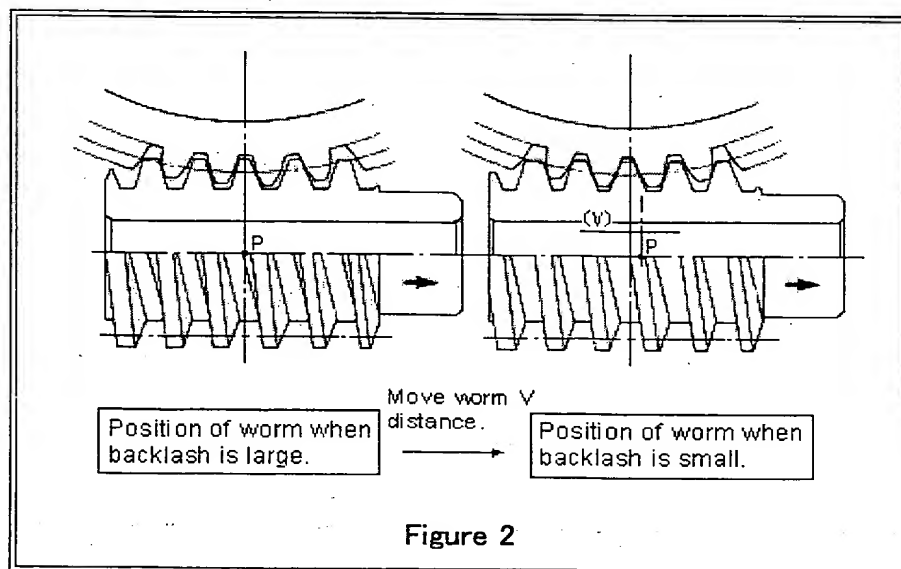


Figure 2

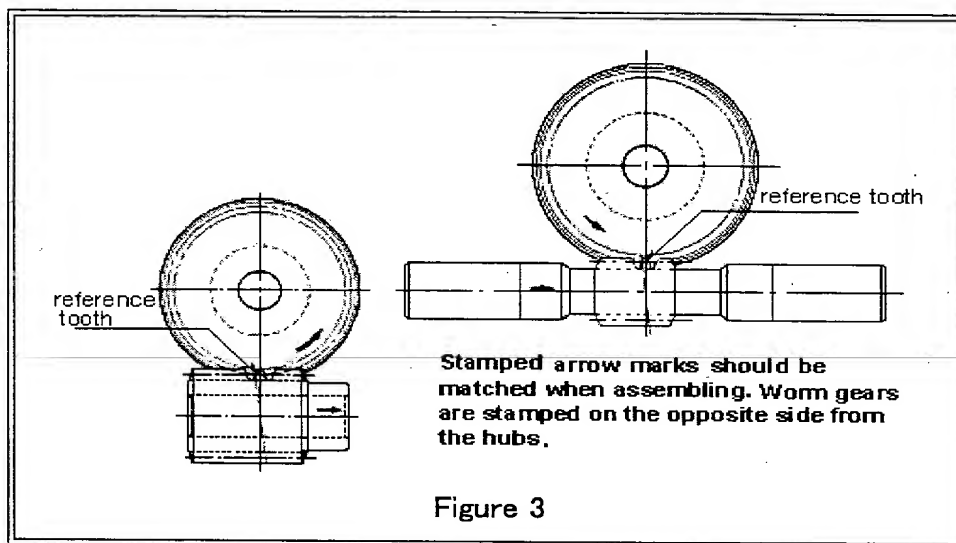
* All KHK duplex worms for any modules are designed such that the axial movement of 1 mm produces change in the backlash of 0.02 mm.

3.Points of Caution on Duplex Worm Gears

Because of asymmetric worm teeth, duplex worms must be oriented correctly with respect to worm gears. Please read the following section carefully before attempting assembly.

Arrow symbols on duplex worms and worm gears

To ensure correct orientation of assembly, duplex worms and worm gears are stamped with arrow marks. Make sure the arrows point in the same direction when assembled. (Figure 3)



Direction of backlash adjustment

Duplex worms have arrow marks on the hubs or shafts to indicate assembly orientation. The arrow point in the direction that the worms should be moved to reduce backlash.

Reference setting position of assembly

The reference setting position of the duplex worms relative to the center of worm gears is indicated by a V-groove ($0.3 \times 60^\circ$) on the circumference of the worms.

Confirmation of correct orientation of worm gears

When there is difficulty in assembling duplex worm gears, it is often the result of wrong orientation of the worm gears. As explained in Figure 3, this can be corrected by turning the worm gears front to back.

Lubrication methods and lubricant

KHK stock duplex worm gears should be lubricated in the same manner as for KHK worm gears (KWG/AGF and SWG/AG combinations). We recommend an oil bath method with worm gear oil.